1. Log in to your Sage/Cocalc account.
   (a) Start the Chrome browser.
   (b) Go to http://cocalc.com and sign in.
   (c) You should see an existing Project for our class. Click on that.
   (d) Click “New”, call it c30, then click “Sage Worksheet”.

2. Try the problem at http://projecteuler.net/problem=8. How will you get that number into your program?? Do not type it in by hand.

A graph is a mathematical object consisting of dots and lines (also called vertices and edges). Sage includes the graphs class which contains a number of methods. Some of these include constructors for making well-known graphs.

3. Evaluate:

   g=graphs.HouseGraph()
g.order()
g.size()
g.show()

   The order of a graph is the number of vertices it has. The size of a graph is the number of edges it has.

4. Let’s get re-acquainted with paths, cycles, stars, and complete graphs. Try
   g=graphs.PathGraph(7), g=graphs.CycleGraph(7), g=graphs.StarGraph(7), and g=graphs.CompleteGraph(7)

5. We can create our own graph using the Graph() constructor. Last class we used add_vertex() and add_edge() methods. Instead of using add_vertex(), you can start with Graph(5) to get a graph with 5 vertices and no edges.

   The type of a graph in Sage is Graph. This is the class that the concrete graph objects like g=graphs.HouseGraph() belongs to. This class contains methods that every concrete graph object has access to. There any numerous methods. To see the methods available to a graph g, just type g. followed by the Tab key.
Our Own Class

The Graph class is sprawling and complicated. Now we’ll design our own class to get a feeling for the main ideas. We’ll design a general class of Dungeons and Dragons character, sample concrete character objects, methods that can be accessed by any character objects, and functions that can be used on the characters.

6. The following code defines a class called `Character`, together with a single method which `constructs` new Characters. What we have in mind is a thing (think of it as a person) that has a `name`.

```python
class Character:
    def __init__(self, name):
        self.name = name

Now we can create characters. Try `c1=Character("John")` to create a character `c1` with the name “John”. We can create as many as we want. Try `c2=Character("Jenn")`.

7. Our characters can’t do anything yet. So let’s add a method so they can introduce themselves.

```python
class Character:
    def __init__(self, name):
        self.name = name
    def hello(self):
        print "Hello world! I am {}.".format(self.name)
```

Evaluate. We must create new characters in order to use the newly defined abilities. Try `c3=Character("Bilbo")`. Then try `c3.hello()`.

8. Now let’s add attributes to our Characters: intelligence, health, strength, and fortitude. We will randomly initialize these as integers from 1 to 10. We would also like to be able to get a status report on these values. So we will add a `status()` method.

```python
class Character:
    def __init__(self, name):
        self.name = name
        self.intelligence=randint(1,10)
        self.health=randint(1,10)
        self.strength=randint(1,10)
        self.fortitude=randint(1,10)
    def hello(self):
        print "Hello world! I am {}.".format(self.name)
    def status(self):
        print "My intelligence is {}".format(self.intelligence)
        print "My health is {}".format(self.health)
        print "My strength is {}".format(self.strength)
        print "My fortitude is {}".format(self.fortitude)
```

Evaluate. Let `c4=Character("Frodo")`. Try `c4.status()`.